International Journal of Agricultural
Science and Research (IJASR)
ISSN(P): 2250-0057; ISSN(E): 2321-0087
Vol. 6, Issue 2, Apr 2016, 73-78

A STUDY ON STORAGE TEMPERATURE OF PADDY IN METAL SILOS

CHIDANAND D V[1] & SHANMUGASUNDARAM S[2]

[1]*Research Scholar, Indian Institute of Crop Processing Technology,*

Thanjavur, Tamil Nadu, India

[2]*Associate Professor, Indian Institute of Crop Processing Technology, Tamil Nadu, India*

ABSTRACT

The study was conducted to check the performance of bulk storage of paddy in metal silos in southern part of India. The study was undertaken at Indian Institute of Crop Processing Technology, Thanjavur, Tamil Nadu. Bulk storage of paddy (ADT-45) in flat bottom, GI Silo was investigated. The silo was equipped with a network of temperature sensors (27 numbers) that allowed for online measurement of temperature inside the silo at a time interval of one hour. No artificial ventilation was provided for the silo. The ambient temperature and relative humidity recorded in Thanjavur, were used to study the temperature variations inside the silo for a period of six months. The milling quality of paddy, germination and insect infestation were analyzed during the period of storage.

KEYWORDS: Paddy, Metal Silos, Storage Temperature, Sensor

Received: Feb 14, 2016; **Accepted:** Feb 23, 2016; **Published:** Feb 24, 2016; **Paper Id.:** IJASRAPR2016010

Research Article

INTRODUCTION

The paddy storage is being practiced from the era of the beginning of civilization. Storage of paddy is an important problem because of seasonal production and location specific (Sawant, 1994), whereas the consumption of rice is throughout the year and it is not location specific. Storage of paddy ensures a constant supply throughout the year and also for distant areas supply. India is one of the world's largest producers of paddy, accounting for 21% (102.5 MT) of total world rice production (Anon 2015). Paddy is India's pre-eminent crop and providing food to about half of the Indian population and it is the staple food of the people living in the eastern and the southern parts of the country. The storage of paddy plays an important role in Thanjavur region of Tamil Nadu, with its climatic conditions like average rain fall of 940 mm and relative humidity in the range of 70-85%. And the temperature of Thanjavur region varies from 28-36^{0}C during the year. The high humid climatic condition is not suitable for long duration storage of paddy. It is very difficult to preserve the quality of paddy in long duration storage with traditional methods of storage.

Primary aim of storage is simply to prevent deterioration of quality of grain. This is done indirectly through control of moisture and air movement, and preventing attack of microorganisms, insects and rodents. Farmers throughout the world store the paddy irrespective of climate condition. The focus for safe paddy is to minimize losses during inventory and storage. Paddy must be stored safely to meet the quality and quantity requirements for various uses. The factors affecting the safe storage are broadly classified as biotic factors (insects, mites and microorganisms) and abiotic factors (paddy temperature, moisture content, storage period and gas compositions). Biotic factors are responsible for affecting the quality of paddy during storage. The paddy storage temperatures depend on the influence of external factors such as radiation, conduction and convection depending

upon the climactic condition. Taking the primary factors, the independent variables are selected for the paddy storage temperatures and thereby conducting experiment, for duration of six months.

Temperature studies on steel silos in North Africa (Baratali, 1992) have been carried out. The studies have assessed the performance of storage systems of cereals and legumes in North African climate situations and its effect on the storage quality of grains and legumes. The study was conducted for three commodities (soft wheat, barley and fava beans) bulk Storage in vertical and horizontal steel silos. The temperature and relative humidity data were utilized for deciding the periods of mechanical ventilation of steel vertical unit and horizontal silo. In this study the ventilation is applied either ambient or refrigerated air. The sampling was carried out at regular intervals to assess the changes in physical properties and rate loss in terms of storage period.

Sawant et al. (2012) conducted studies on effect of temperature, relative humidity and moisture content on germination percentage of wheat stored in different storage structures (GI silo, godown and cover and plinth (CAP)) for a period of six months duration. The moisture content in the silo increased from 11.20% to 17.08% (w.b). The temperature of grain inside the silo also increased from 29.30 ^{0}C to 32.31^{0}C at the end of the storage period. The germination percentage of wheat decreased from 86.7% to 78.6% in silo, 86.7% to 53.3% in godown storage and 86.7% to 46.6% in CAP storage. Jian et al. (2009) studied the temperature fluctuations and moisture migrations in wheat stored for a period of 15 months in metal silo in Canada. In this study, they have observed larger temperature fluctuations in the head space than inside the grain mass and the grain moisture inside the mass changed less than that at the surface of grain mass.

This study was conducted to check the performance of bulk storage of paddy in metal silos in southern part of India for a period of 6 months (July 2015 to December 2015).

MATERIALS AND METHODS

The study was conducted in GI (Galvanised iron) silo in Institute of Crop Processing Technology, Thanjavur, Tamil Nadu, South India. The paddy (ADT-45) was procured from Rice Research Institute, Aduthurai, Tamilnadu. The GI silo used for studies was of five ton capacity, 1.07 m height and 2.4 m diameter with a conical roof Figure 1. The silo was manufactured by Western & Foulers Ltd, Bangalore and it is installed on a reinforced concrete platform. Grain handling is carried out mechanically by screw conveyor 1.5 t/hour filling and emptying rate. The study was conducted for a period of six months from July 2015 to December 2015.

Figure 1: Flat Bottom Silo

The internal temperature of the silo was measured using k-type thermocouples connected to a temperature data logger at intervals of one hour. A total of 27 numbers of *k*-type thermocouples Figure 2 were connected in three layers and 9 thermocouples per each layer with equal distance. The data store capacity of data logger is 10000 readings of all 16 channels. The supply of current was 230 V AC and accuracy of the instrument was ±0.25%. The relative humidity sensor was used to measure relative humidity outside and inside the storage silo.

Figure 2: *K*-Type Thermocouples

Moisture content: Hot air oven method was used for moisture determination. The paddy was kept in the oven at a temperature of 130°C ± 1°C for 3 hrs (AOAC Method). The samples were drawn from the silo at three locations (bottom, middle and top layers) by using sampler probe developed at IICPT by using PVC Pipe. The moisture content at different layers of the grain in silo was determined at an interval of 15 days once. The moisture content is expressed as percentage on wet basis (w.b).

$$\text{Moisture Content (w.b)} = \frac{W_1 - W_2}{W_1} * 100$$

Where, W_1 = Weight of sample taken, g; W_2 = Weight of sample after drying, *g*

Milling: To determine the storage quality of paddy millling test was conducted at by using the procedure prescribed by Food Corporation of India (FCI). The percentage rice yield and Broken rice percentage were calculated using the following equations.

$$\text{Percentage Rice Yield} = \frac{\text{Brow Rice}}{\text{Raw Paddy}} \times \frac{\text{Percentage of white rice}}{\text{Brown rice taken for polish}} \times 100$$

$$\text{Broken rice (\%)} = \frac{\text{Weight of broken rice}}{\text{Weight of milled rice}} \times 100$$

Germination: Germination of stored paddy was determined by using, between the paper method (Holly, 2006). In this method, ten grains from each sample with three replications were selected and placed in a moist filter paper. This sample was placed in room temperature for seven days. The samples were removed after seven days and checked for sprouted grains. Germination percentage was calculated as below:

$$\text{Germination (\%)} = \frac{\text{Number of grains sprouted}}{\text{Total Number of grains taken}} \times 100$$

RESULTS AND DISCUSSIONS

Grain Temperature

The study was conducted for a period of six months from July 2015 to December 2015. The initial temperature in July (first day of storage) of the paddy grain inside the silo was 36.41 °C, while at the end of the storage period the temperature was 28.23 °C. The relationship between the ambient and inside temperature of silo is presented in Figure 3. It was observed that during the first three months of storage, inside temperature was near and lesser than the ambient temperature observed in Thanjavur (36.37 °C). The quality of the grains during the first three months was good and there was no or very less infestation. The temperature inside the silo reduced drastically from 35 °C to 28.23 °C in next three months period of the storage. The reduction in the temperature was because of the lower ambient temperature and the relative humidity observed was 95 to 97 %, which were similar to the results observed by Sawant *et al.* (2012).

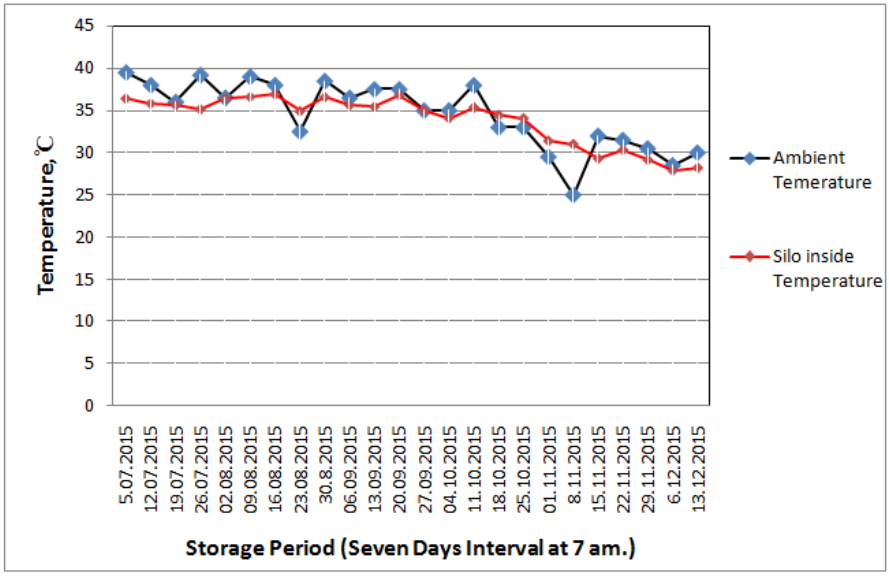

Figure 3: Relationship between Ambient Temperature and Temperature Absorbed Inside the Paddy Storage Silo

Relative Humidity (%)

The relative humidity recorded inside the silo was lower than the ambient relative humidity Figure 4. The reason for the lower relative humidity recorded inside the silo as the storage structure was partially air tight. However, the relative humidity in silo showed increasing trend with respect to the ambient relative humidity at the end of the storage period. The initial relative humidity inside the silo was 55 % and at the end of the storage period, it was 65 %.

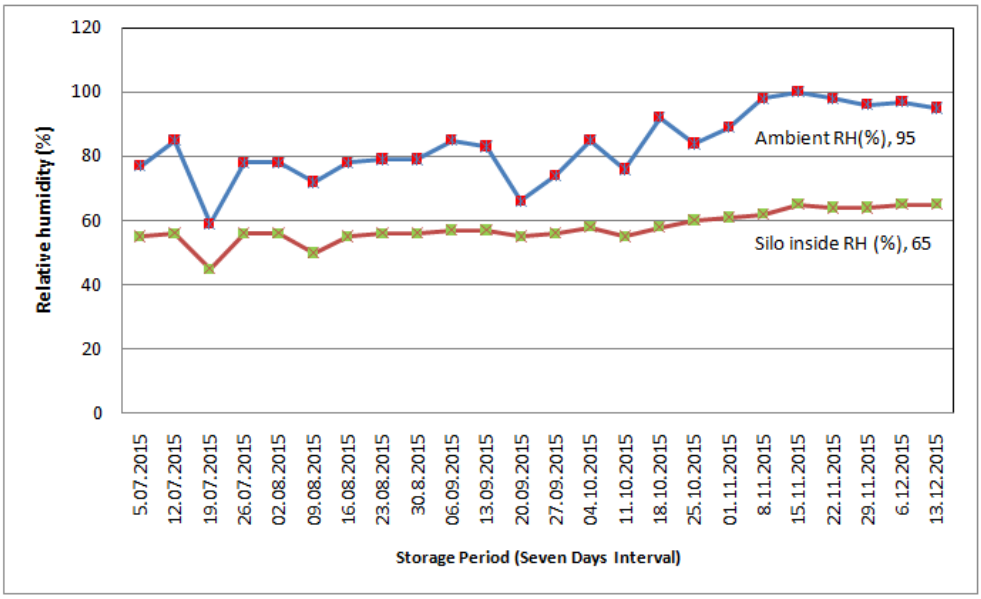

Figure 4: Relationship between Ambient Relative Humidity (%) and Relative Humidity Absorbed Inside the Paddy Storage Silo

Milling Quality of Storage Paddy

The change in milling qualities of stored paddy which was stored in silo is shown in the Figure 5. The Pry and broken percentage was calculated during the period of storage. During the initial stages of storage the PRY (Percentage Rice yield) of paddy was 73.44 % and broken percentage of 32%. The milling quality observed was good in all the months during study period, and the broken percentage reduced to 28 % in the last month of storage from 32 % (First month). The results observed during milling may be due to ageing of paddy.

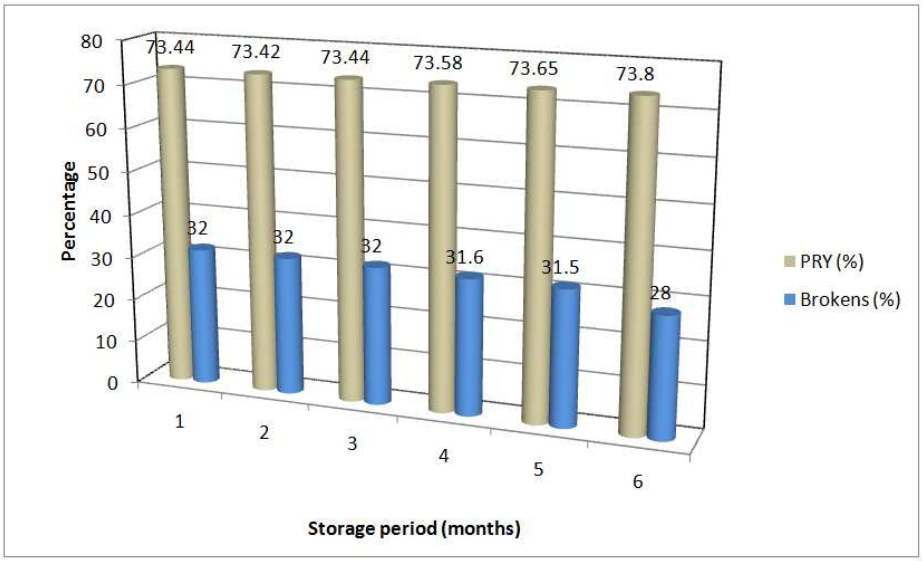

Figure 5: Variation in the Milling Qualities of Stored Paddy in Metal Silo

Germination Percentage

The variation in germination percentage during storage of paddy in silo is shown in Figure 6. The germination percentage decreased to 72 % at the end of the storage period. The germination percentage observed in the earlier storage

period was 77%. The germination percentage decreased with the storage period. The paddy used for the storage was of low germination quality of less than 80 %.

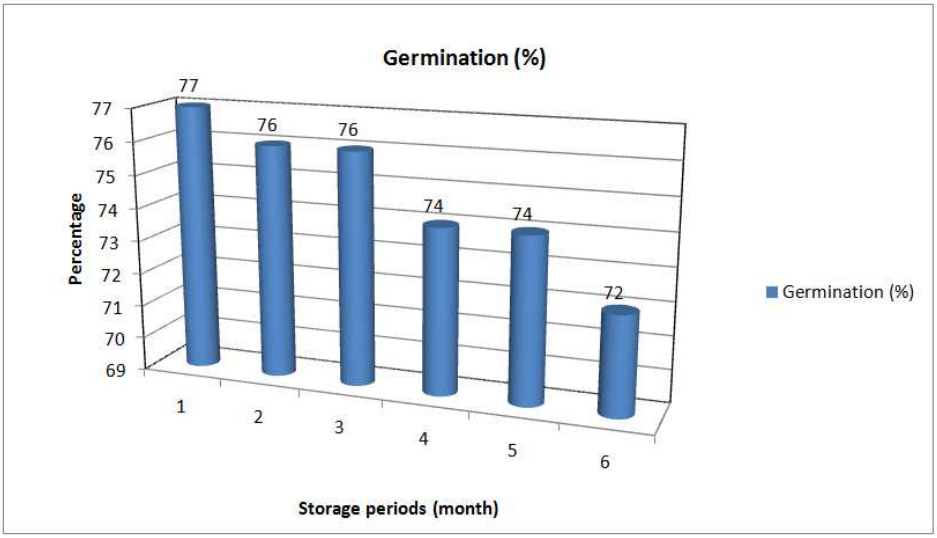

Figure 6: Variation in Germination Percentage during the Storage of Paddy in Metal Silo

CONCLUSIONS

This study shows the technical and managerial issues regarding storing the paddy at metal silos in Thanjavur location. The initial temperature of the Paddy grain inside the silo was 36.41°C, while at the end of the storage period, the temperature was 28.23°C. The relative humidity inside the silo was 14.2% lower than ambient relative humidity. The temperature distribution in non-aerated paddy stored in metal silo was more acceptable even though the grain moisture content was 11-12.5% (w.b). The reason is that storage structure is partially air tight (bolted silo). The common practice existing among the paddy cultivars to store paddy is 12 - 14 percent moisture for a minimum period of six months to maintain the sustainability. Considering the benefits in the silo storage practice, this approach can be extended to other commodities for which market value is sensitive to quality attribute of grains.

REFERENCES

1. *Anonymous, 2015. Economic Survey of India for 2015. Directorate of Stastics Planning, Govt of India.*
2. *Bartali, H. 1992. Monitoring and eavaluation of grain storage systems. International Sympoism on Stored Grain Ecosystems, organized by Department of Agricultiral Engineering, University of Manitoba, Winnipeg, Canada, 7–11 June 1992.*
3. *Jian, F, Jayas, D. S., White N. D. G., 2009. Temperature fluctations and moisture migration in wheat stored for 15 months in a metal silo in Canada, Journal of Stored Products research, Vol – 45, 82–90.*
4. *Sawant, A. A, Patil, S. C, Kalse, S.B and THakor, N. J.2012. Effect of Temperature, relative humidity and moisture on germination of wheat stored in different storage structures. Agri Eng: CIGR Journal Vaolume 14 No 2, PP 110–118.*
5. *Holly, S. K 2006. Seed Germination. Library, Gardening in Western Washington, Presented by WSU Extension.*
6. *Sawant, S.D1994. Modern grain storage for reducing storage losses. Agricultural Engineering Today (1)4:12–20.*